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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/584,052
Filing Date: June 22, 2006
Appellant(s): POCAS ET AL.

Philippe J.C. Signore
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 8/30//2011 appealing from the Office action mailed 2/1/2011.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The following is a list of claims that are rejected and pending in the application:

Claims 27-29, 31-45, 53-57 and 65

(4) Status of Amendments After Final

The examiner has no comment on the appellant's statement of the status of amendments after final rejection contained in the brief.

(5) Summary of Claimed Subject Matter

The examiner has no comment on the summary of claimed subject matter contained in the brief.

(6) Grounds of Rejection to be Reviewed on Appeal

The examiner has no comment on the appellant's statement of the grounds of rejection to be reviewed on appeal. Every ground of rejection set forth in the Office action from which the appeal is taken (as modified by any advisory actions) is being maintained by the examiner except for the grounds of rejection (if any) listed under the

subheading "WITHDRAWN REJECTIONS." New grounds of rejection (if any) are provided under the subheading "NEW GROUNDS OF REJECTION."

(7) Claims Appendix

The examiner has no comment on the copy of the appealed claims contained in the Appendix to the appellant's brief.

(8) Evidence Relied Upon

US Patent 6,054,369	Neilson et al	4-2000
US Patent 5,654,241	Kakumu	8-1997
US Patent 4,577,396	Yamamoto et al	3-1986
US Patent 5,783,477	Kish, Jr. et al	7-1998
US 2002/0157790 A1	Abe et al	10-2002
US 6,274,892 B1	Kub et al	8-2001
US 6,410,371 B1	Yu et al	6-2002
US Patent 4,181,538	Narayan et al	1-1980
US 2003/0057522 A1	Francis et al	3-2003
US Patent 5,354,697	Oostra et al	10-1994
US Patent 5,236,872	Van Ommen et al	8-1993

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claim 27-29, 34-36, 41-43, 45; 53, 54; and 65 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neilson et al (6,054,369-prior art of record) in view of Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record).

Re claim 27, Neilson et al disclose in FIGS. (2a or 2b or 2c or 2d) and 3 a method of sealing a first wafer (N^- Si 22 in FIGS. 2a-d) and a second wafer (N^+ Si below buffer layer 24 in FIGS. 2a-d) each made of semiconducting (silicon) materials, comprising:

implanting a metallic (Pt, Cu, Ni or Co centers "x" in FIGS. 2a-d) species in at least the first wafer (either first or second wafer or both) at a dose above 10^{14} species/cm^2 (10^{19} species/cm^3), assembling the first wafer and the second wafer by molecular bonding, wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface. (column 3, lines 7-20, 47-67; column 4, lines 1-55; column 5, lines 5-22)

Neilson et al fail to disclose at a dose above 10^{16} species/cm^2.

Kakumu discloses in FIG. 2D implanting a metallic (Mo, W, Ni, Pt, Pd, Ta, etc.) species in at least the first wafer (Si substrate 10) at a dose above 10^{16} species/cm^2 ($3x10^{17}$/cm^2) to form reduced areas of resistance for ohmic contacts (column 3, lines 6-9, 28-53; column 4, lines 43-47; column 6, lines 53-60 and column 8, lines 1-7).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant dosage of Kakumu with the method of Neilson et al to form areas of reduced resistance to carrier flow. (Kakumu, Title, Abstract and column 8, lines 1-7)

Further, Neilson et al fail to disclose explicitly disclose after the molecular bonding, forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second water, said metallic ohmic contact being formed at an assembly interface between the first wafer and the second wafer.

Yamamoto et al disclose forming a metallic ohmic contact including alloys and silicides formed between the implanted metallic species (W, Mo, Ti) at doses above $5x10^{16}$ species/cm2 and the semiconducting materials of a wafer, said metallic ohmic contact being formed from the surface of the wafer to a depth of 5 nm, wherein the forming includes causing the implanted metallic species to diffuse towards the surface of the wafer. (column 2, lines 15-33; column 3, lines 1-23 and column 6, lines 32-68)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant species and dosage of Yamamoto et al with the method of Neilson et al and Kakumu to form alloyed or silicide areas of reduced resistance to electrical contacts. (Yamamoto et al, Title, Abstract and column 2, lines 15-33).

However, it should be noted that since Neilson et al disclose suitable heat treatment can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or

silicides which would function as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 1017 to 1021 species/cm3 which would be satisfied by dosages above 1014 species/cm2) contacts.

Re claim 28, Neilson et al make obvious the claimed limitations of wherein the forming includes applying a heat treatment at a temperature equal at least to a formation temperature of the said alloys since it is disclosed that a suitable heat treatment (at least 800° C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), thus causing the metallic species react with the silicon wafers to form metallic-silicon alloys and silicides (column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22) since both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C.

Re claim 29, Neilson et al disclose implanting the metallic species (Pt, Ni, Co or Cu) under a surface of the first wafer (N^- Si 22 in FIGS. 2a-d). (column 3, lines 47-67; column 4, lines 1-55)

Neilsonet al fail to disclose at a depth (Rp) of between 5 nm and 20 nm under a surface of the first wafer.

Yamamoto et al disclose forming a metallic ohmic contact including alloys formed between the implanted metallic species (W, Mo, Ti) at doses above $5x10^{16}$ species/cm^2 and the semiconducting materials of a wafer, said metallic ohmic contact being formed from the surface of the wafer to a depth of 5 nm. (column 2, lines 15-33; column 3, lines 1-23 and column 6, lines 32-68)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant depth of Yamamoto et al with the method of Neilson et al and Kakumu to form alloyed or silicide areas of reduced resistance to electrical contacts. (Yamamoto et al, Title, Abstract and column 2, lines 15-33)

Re claim 34, Neilson et al disclose the first wafer (N^- Si 22 in FIGS. 2a-d) and the second wafer (N^+ Si below buffer layer 24 in FIGS. 2a-d) being made from silicon. (column 5, lines 14-22)

Re claim 35, Neilson et al disclose the implanted species includes one of platinum, nickel, cobalt or copper. (column 4, lines 36-55)

Re claim 36, Neilson et al disclose at least one of the wafers is heterostructure (N^- Si 22 in FIGS. 2a-d comprises a dielectric on its top surface).

Re claim 41, Neilson et al disclose at least one of the wafers includes at least one circuit or circuit layer. (N^- Si 22 in FIGS. 2a-d comprises a dielectric and a polysilicon circuit layer on its top surface)

Re claim 42, 43 and 45, Neilson et al disclose forming of an insulating layer (N^- Si 22 in FIGS. 2a-d comprises a dielectric on its top surface) on the first wafer.

Neilson et al fail to disclose implanting includes using a mask to obtain local implantation zones; and before the implanting; and wherein the first wafer includes at least one insulating zone at a surface so as to obtain local implantation zones

Yamamoto et al disclose in FIGS. 1a-b forming of a patterned (mask) insulating layer (oxide 6) on a wafer (Si 1) before the implantation (Ti 4) so as to obtain local implantation zones at and below a surface. (column 3, lines 40-68)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the patterned insulating of Yamamoto et al with the method of Neilson et al and Kakumu to perform selective implantation for a semiconductor device.

Re claim 53, Neilson et al disclose in FIGS. (2a or 2b or 2c or 2d) and 3 a method of sealing a first wafer (N^- Si 22 in FIGS. 2a-d) and a second wafer (N^+ Si below buffer layer 24 in FIGS. 2a-d) each made of semiconducting (silicon) materials, comprising:

implanting a metallic (Pt, Cu, Ni or Co centers "x" in FIGS. 2a-d) species in at least the first wafer (either first or second wafer or both) at a dose above 10^{14} species/cm^2 (10^{19} species/cm^3), assembling the first wafer and the second wafer by molecular bonding, wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface. (column 3, lines 7-20, 47-67; column 4, lines 1-55; column 5, lines 5-22)

Neilson et al fail to disclose at a depth (Rp) of between 5 nm and 20 nm under a surface of the first wafer, at a dose above 10^{16} species/cm^2.

Kakumu discloses in FIG. 2D implanting a metallic (Mo, W, Ni, Pt, Pd, Ta, etc.) species in at least the first wafer (Si substrate 10) at a dose above 10^{16} species/cm^2 ($3x10^{17}$/cm^2) to form reduced areas of resistance for ohmic contacts (column 3, lines 6-9, 28-53; column 4, lines 43-47; column 6, lines 53-60 and column 8, lines 1-7).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant dosage of Kakumu with the method of Neilson et al to form areas of reduced resistance to carrier flow. (Kakumu, Title, Abstract and column 8, lines 1-7)

Further, Neilson et al fail to disclose explicitly disclose after the molecular bonding, forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the

second water, said metallic ohmic contact being formed at an assembly interface between the first wafer and the second wafer.

Yamamoto et al disclose forming a metallic ohmic contact including alloys or silicides formed between the implanted metallic species (W, Mo, Ti) at doses above $5x10^{16}$ species/cm^2 and the semiconducting materials of a wafer, said metallic ohmic contact being formed from the surface of the wafer to a depth of 5 nm, wherein the forming includes causing the implanted metallic species to diffuse towards the surface of the wafer. (column 2, lines 15-33; column 3, lines 1-23 and column 6, lines 32-68)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant species, dosage and depth of Yamamoto et al with the method of Neilson et al and Kakumu to form alloyed or silicide areas of reduced resistance to electrical contacts. (Yamamoto et al, Title, Abstract and column 2, lines 15-33)

However, it should be noted that since Neilson et al disclose suitable heat treatment can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally

have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts.

Re claim 54, Neilson et al make obvious the claimed limitations of wherein the forming includes applying a heat treatment at a temperature equal at least to a formation temperature of the said alloys since it is disclosed that a suitable heat treatment (at least 800° C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), thus causing the metallic species react with the silicon wafers to form metallic-silicon alloys and silicides (column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22) since both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C.

Re claim 65, Neilson et al disclose in FIGS. (2a or 2b or 2c or 2d) and 3 a method of sealing a first wafer (N^- Si 22 in FIGS. 2a-d) and a second wafer (N^+ Si below buffer layer 24 in FIGS. 2a-d) each made of semiconducting (silicon) materials, comprising:

implanting a metallic (Pt, Cu, Ni or Co centers "x" in FIGS. 2a-d) species in at least the first wafer (either first or second wafer or both) at a dose above 10^{14} species/cm^2 (10^{19} species/cm^3), assembling the first wafer and the second wafer by molecular bonding, wherein the forming includes causing the implanted metallic species

to diffuse towards the interface between the first wafer with the second wafer and beyond the interface. (column 3, lines 7-20, 47-67; column 4, lines 1-55; column 5, lines 5-22)

Neilson et al fail to disclose at a dose above 10^{16} species/cm^2.

Kakumu discloses in FIG. 2D implanting a metallic (Mo, W, Ni, Pt, Pd, Ta, etc.) species in at least the first wafer (Si substrate 10) at a dose above 10^{16} species/cm^2 ($3x10^{17}/cm^2$) to form reduced areas of resistance for ohmic contacts (column 3, lines 6-9, 28-53; column 4, lines 43-47; column 6, lines 53-60 and column 8, lines 1-7).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant dosage of Kakumu with the method of Neilson et al to form areas of reduced resistance to carrier flow. (Kakumu, Title, Abstract and column 8, lines 1-7)

Further, Neilson et al fail to disclose explicitly disclose after the molecular bonding, forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second water, said metallic ohmic contact being formed at an assembly interface between the first wafer and the second wafer.

Yamamoto et al disclose forming a metallic ohmic contact including a alloy or silicide formed between the implanted metallic species (W, Mo, Ti) at doses above $5x10^{16}$ species/cm^2 and the semiconducting materials of a wafer, said metallic ohmic

contact being formed from the surface of the wafer to a depth of 5 nm, wherein the forming includes causing the implanted metallic species to diffuse towards the surface of the wafer. (column 2, lines 15-33; column 3, lines 1-23 and column 6, lines 32-68)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the implant species and dosage of Yamamoto et al with the method of Neilson et al and Kakumu to form alloy or silicide areas of reduced resistance to electrical contacts. (Yamamoto et al, Title, Abstract and column 2, lines 15-33)

However, it should be noted that since Neilson et al disclose suitable heat treatment can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts.

4. Claims 31-33 and 55-57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neilson et al and Kakumu and Yamamoto et al as applied to claims 27 and 53 above, and further in view of Kish, Jr. et al (5,783,477-prior art of record) and Abe et al (US 2002/0157790 A1-prior art of record).

Re claims 31-33 and 55-57, Neilson et al and Kakumu and Yamamoto et al fail to disclose processing the first wafer to make all or part of a surface layer of the first wafer amorphous; and wherein the processing the includes depositing an amorphous material layer before and/or after implantation of the metallic species; wherein the processing includes implanting hydrogen.

Kish, Jr. et al disclose in FIG. 9 an amorphisation step before assembly to make all or part of the surface layer (93 or 95; column 8, lines 18-37) of the first wafer (semiconductor layer under 93 or 95) amorphous; and the amorphisation step comprising deposition of an amorphous material layer (91; column 8, lines 18-37); and the amorphisation step comprising a surface implantation (column 8, lines 18-37).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the amorphisation step before assembly to make all or part of the surface layer of the first wafer amorphous; and the amorphisation step comprising deposition of an amorphous material layer; and the amorphisation step comprising a surface implantation of Kish, Jr. et al with the method of Neilson et al and Kakumu and Yamamoto et al to form an ohmic interface between unipolar semiconductor wafers. (Kish, Jr. et al Abstract)

Neilson et al and Kakumu and Yamamoto et al and Kish, Jr. et al fail to disclose the amorphisation step comprising a surface implantation of hydrogen.

Abe et al disclose in FIGS. 2-3 the amorphisation step comprising a surface implantation, for example by hydrogen. (¶ [0064])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the amorphisation step comprising a surface implantation, for example by hydrogen of Abe et al with the method of Neilson et al and Kakumu and Yamamoto et al and Kish, Jr. et al to produce bonded wafers comprising an ion implantation of hydrogen without causing breakage of the wafers. (Abe et al Abstract)

5. Claims 37, 38 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neilson et al and Kakumu and Yamamoto et al as applied to claim 27 above, and further in view of Kub et al (US 6,274,892 B1-prior art of record).

Re claims 37 and 44, Neilson et al and Kakumu and Yamamoto et al fail to disclose thinning at least one of the wafers after the assembling or after the forming of the metallic compounds; and thinning the first wafer after implantation of the metallic species.

Kub et al disclose at least one of the wafers (80 in FIG. 2) being thinned, before the implantation and formation step of metallic compounds (Pt). (column 5, lines 62-67, column 6, lines 66-67 and column 7, lines 1-5)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the wafer thinning of Kub et al with the method of Neilson et al and Kakumu and Yamamoto et al to form devices by low temperature direct bonding. (Kub et al, Title)

Further, it would have been obvious to one of ordinary skill in the art at the time the invention was made to thin at least one of the wafers after the assembling or after the forming of the metallic compounds; and to thin the first wafer after implantation of the metallic species since the selection of any order of performing process steps is *prima facie* obvious in the absence of new or unexpected results. *In re Burhans*, 154 F.2d 690, 69 USPQ 330 (CCPA 1946); *In re Gibson*, 39 F.2d 975, 5 USPQ 230 (CCPA 1930). See MPEP § 2144.04.

Re claims 38, Neilson et al and Kakumu and Yamamoto et al fail to disclose at least one of the wafers being is a debondable structure.

Kub et al disclose at least one of the wafers being a debondable structure. (wafers 80 and 95 are both debondable since the are bonded by low energy molecular (hydrophobic) bonding as is disclosed by the applicant; column 9, lines 37-61)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use the debondable wafer(s) structure bonding of Kub et al with the method of Neilson et al and Kakumu and Yamamoto et al to form devices by low temperature direct bonding. (Kub et al, Title)

6. Claims 39 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neilson et al and Kakumu and Yamamoto et al as applied to claim 27, and further in view of Yu et al (US 6,410,371 B1-prior art of record).

Re claims 39 and 40, Neilson et al and Kakumu and Yamamoto et al fail to disclose at least one of the wafers includes a weakening plane; and thinning the wafer including the weakening plane by fracture along the said weakening plane, after the assembling or after the forming of the metallic compounds.

Yu et al disclose in FIGS. 2 and 3A-3F at least one of the wafers (64 in FIG. 3E) including a weakening plane (weak zone); and the wafer including a weakening plane being thinned by fracture (broken) along the said weakening plane. (column 4, lines 19-43)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to substitute the at least one of the wafers comprising a weakening plane of Yu et al for one of the wafers of Neilson et al; and to use the wafer comprising a weakening plane being thinned by fracture along the said weakening plane of Yu et al with the method of Neilson et al and Kakumu and Yamamoto et al to form a semiconductor-on-insulator (SOI) wafer. (Yu et al Abstract)

(10) Response to Argument

Appellant's arguments filed 8/30/2011 have been fully considered but they are not persuasive:

1.

A. In Re appellant's arguments that "Neilson is concerned with the switching speed of transistors……The purpose of Neilson to is to provide "recombination centers

of a semiconductor device [that] are concentrated in a buffer layer or near a wafer-to-wafer bonding interface…The density of the recombination centers may be controlled by doping one or both of the bonding surfaces with a suitable dopant or dopants…….In Neilson, the concentration of 10^{14} cm^3 to 10^{19} cm^3 is far too low to make an ohmic contact (see Sze, page 187, first sentence of §3.6: "An ohmic contact is defined as a metal-semiconductor contact that has a negligible junction resistance relative to the total resistance of the semiconductor device" [emphasis added])……With the concentrations given in Neilson, recombination centers are made, and any reaction between the dopants and the substrate is too insignificant to form an ohmic contact…..The doses employed in Neilson are therefore much lower than the claimed at least $10^{16}/cm^2$…….Col. 4, 11.57-59 of Neilson states "the dopant may be selected to provide optimum switching performance (if this is desired) without regard for its solubility or diffusion coefficient……The "without regard for its solubility or diffusion coefficient" is in agreement with a very low concentration, very far from saturation where solubility is not yet a problem. The Examiner fails to make any findings of fact, supported by substantial evidence, to support a contrary position. Furthermore, Neilson fails to disclose the claimed "wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface." As explained at col. 4, 11.46-49 of Neilson, a high temperature treatment is "to distribute the dopants in what will become buffer layer 24 and establish the desired concentration." There is no disclosure that the dopants diffuse beyond the interface (i.e., the interface between elements 22 and 24 of Neilson.Thus, Neilson at least differs from

Claims 27, 53, and 65 in the doping concentration used, the formation of an ohmic contact at an assembly interface between the first wafer and the second wafer, and that the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface."

The examiner, respectfully, disagrees and takes the position that the recombination centers 20 formed in buffer layer 24 in FIGS. 2a-d would still function as recombination centers if an ohmic contact is formed since:

a. Narayan et al (4,181,538) disclose that recombination centers are present in silicon wafers up to a concentration of Cu or Fe (both of which are used by Neilson) of over $5x10^{21}/cm^3$ which corresponds to a dosage of over $10^{16}/cm^2$ (FIG. 6; column 11, lines 55-68 and column 12, lines 1-68).

b. Francis et al (2003/0057522 A1) disclose heavy metal (e.g. Au or Pt as does Neilson) ion implantation for forming recombination centers (FIGS. 1-3; ¶ [0011]-[0017]) in transistor structures.

c. Oostra et al (5,354,697) disclose forming NiSi (nickel silicide) layers in silicon wafers by ion implantion of Ni (Neilson discloses Ni recombination centers) with doses up to $3x10^{17}/cm^2$ (col. 8, lines 42-68 and col. 9, lines 1-48).

d. van Ommen et al (5,236,872) disclose forming $CoSi_2$ (cobalt silicide) layers in silicon wafers by implanting Co (Neilson discloses Co recombination centers) with doses up to $2.6x10^{16}/cm^2$ (col. 1, lines 55-61 and col. 2, lines 1-40).

The above cited references disclose that the metal ion implantations (applicant discloses Co, Ni, Ti, Cu or Pt) can be used for different applications which have varying degrees of quality dependent on the implantation and the subsequent anneal conditions. They all disclose formation of silicon-alloys (i.e. metal silicides) layers on or below the surface of a silicon wafer.

Neilson et al have not disclosed any limitations or restrictions which would preclude its structure from being implanted with a dose consistent with the claimed dosage of $10^{16}/cm^2$. This assertion, in conjunction with the above cited references, disclose forming recombination centers in silicon wafers comprising Co, Ni, Ti, Cu or Pt implants with dosages up to $2.6x10^{16}/cm^2$ wherein silicides may be formed in conjunction with the recombination centers, and further provide evidence that such a formation of recombination centers at such a dosage would not destroy the operational intent of Neilson.

Thus, when the combination of the secondary references to Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record) are applied to Neilson, the formation of recombination centers in the devices of Neilson remains unchanged since Neilson et al disclose suitable heat treatment (at least 800° C) can be

performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts. (Neilson et al, column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22)

While both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C at implant dosages substantially identical to Neilson et al (above 10^{14} species/cm^2). Thus, similar properties are presumed. Taken further, the wafer, implant species and doses, and annealing of Neilson et al in view of Kakumu and Yamamoto et al are identical to applicant disclosed and/or claimed wafers (silicon), implant species and doses, and annealing.

Thus, it would be expected that the results to be similar with respect to diffusion and ohmic contact formation. Therefore, a prima facie case of obviousness has been established since the combination of Neilson et al and Kakumu and Yamamoto et al discloses a substantially identical structure which is produced by a substantially

identical process to the specification disclosed process and the claimed method. See MPEP § 2112.01 and 2112.02.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the recombination centers of Neilson as ohmic contacts since Neilson and the prior art of record to Kakumu and Yamamoto et al disclose process variations which affect the final device structure's performance; none of which would change the principal operation of Neilson et al as is evidenced by the above cited references a-d.

And, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ 2d 1647 (1987). See MPEP § 2114 [R-1].

B. In Re appellant's arguments that **"**A person of ordinary skill in the art would not modify Neilson to include an ohmic contact at the interface of bonding surfaces. The purpose of Neilson is to form recombination centers. Elimination of the recombination centers would render Neilson unsatisfactory for its intended purpose (see, col. 2, line 40 to col. 3, line 27 of Neilson).....Changing the recombination centers to an ohmic contact would change the principle of operation of the device of Neilson since the recombination centers are an integral part of the semiconductor device of Neilson. The dopants would be concentrated in the ohmic contact because

they have a low density in the material. No recombination centers would remain to provide the needed "layer adjacent a blocking layer of a semiconductor device is provided with a significantly higher density of recombination centers. There is no evidence to support a position that Neilson includes or should include both recombination centers and an ohmic contact formed at an assembly interface between the first wafer and the second wafer. Appellants respectfully submit that a person of ordinary skill in the art would not modify Neilson to have both recombination centers and an ohmic contact. Neilson states "a layer adjacent a blocking layer of a semiconductor device is provided with a significantly higher density of recombination centers. To the extent it is even possible to modify Neilson so that some of the recombination centers are changed into an ohmic contact, such a modification would frustrate the above-noted purpose of Neilson as it would alter the density of the recombination centers. In addition, col. 2, lines 51-57 of Neilson describes that recombination centers are substantially absent from the blocking layer. Thus, there is no reason to have recombination centers or an ohmic contact at the blocking layer. Neilson describes transistors. It does not make sense to form an ohmic contact at the blocking layer and/or buffer layer of Neilson. Neilson concerns an interface between NP regions of a transistor (see Figs. 2C or 2D) or an interface with a blocking layer (see Figs. 2A or 1D). A person of ordinary skill in the art would not form an ohmic contact at an interface with a blocking layer which, roughly speaking, aims to block charge circulation. Col. 1, lines 59 to col. 2, line 19 of Neilson describes that the blocking layer has a high resistance, which is contradictory with having an ohmic contact. Ohmic contacts are not built where

resistivity is to be kept high. The blocking layer is also for having a low leakage current (see, col. 1, line 61 of Neilson), which again is contradictory with having an ohmic contact at the interface with the blocking layer. What is important in Neilson in selecting a dopant is not its ability to react with the substrate. Rather, Neilson is concerned with the energy levels (see, col. 5, lines 5-7 in combination with col. 1, lines 31-36 of Neilson.). If the dopants of Neilson were suppose to react with the substrate, the energy levels of the dopants would be totally different and their ability to form recombination centers would be lost.....Thus, Neilson does not disclose "forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second wafer. The PTO cannot base rejections on assumptions instead of established facts.....It may not, because it may doubt that the invention is patentable, resort to speculation, unfounded assumptions or hindsight reconstruction to supply deficiencies in its factual basis (emphasis added)."

The examiner, respectfully, disagrees and takes the position that the recombination centers 20 formed in buffer layer 24 in FIGS. 2a-d would still function as recombination centers if an ohmic contact is formed since as stated above:

a. Narayan et al (4,181,538) disclose that recombination centers are present in silicon wafers up to a concentration of Cu or Fe (both of which are used by Neilson) of over $5x10^{21}/cm^3$ which corresponds to a dosage of over $10^{16}/cm^2$ (FIG. 6; column 11, lines 55-68 and column 12, lines 1-68).

b. Francis et al (2003/0057522 A1) disclose heavy metal (e.g. Au or Pt as does Neilson) ion implantation for forming recombination centers (FIGS. 1-3; ¶ [0011]-[0017]) in transistor structures.

c. Oostra et al (5,354,697) disclose forming NiSi (nickel silicide) layers in silicon wafers by ion implantion of Ni (Neilson discloses Ni recombination centers) with doses up to $3x10^{17}/cm^2$ (col. 8, lines 42-68 and col. 9, lines 1-48).

d. van Ommen et al (5,236,872) disclose forming $CoSi_2$ (cobalt silicide) layers in silicon wafers by implanting Co (Neilson discloses Co recombination centers) with doses up to $2.6x10^{16}/cm^2$ (col. 1, lines 55-61 and col. 2, lines 1-40).

The above cited references disclose that the metal ion implantations (applicant discloses Co, Ni, Ti, Cu or Pt) can be used for different applications which have varying degrees of quality dependent on the implantation and the subsequent anneal conditions. They all disclose formation of silicon-alloys (i.e. metal silicides) layers on or below the surface of a silicon wafer.

Neilson et al have not disclosed any limitations or restrictions which would preclude its structure from being implanted with a dose consistent with the claimed dosage of $10^{16}/cm^2$. This assertion, in conjunction with the above cited references,

disclose forming recombination centers in silicon wafers comprising Co, Ni, Ti, Cu or Pt implants with dosages up to $2.6x10^{16}/cm^2$ wherein silicides may be formed in conjunction with the recombination centers, and further provide evidence that such a formation of recombination centers at such a dosage would not destroy the operational intent of Neilson.

In fact, Neilson et al disclose that device speed is dependent on doping concentration (up to $10^{19}/cm^3$) corresponding to doses above $10^{14}/cm^2$ of the recombination centers (column 4, lines 35-55). Therefore, higher doping concentrations of the recombination centers is permissible via doses above $10^{14}/cm^2$ up to $2.6x10^{16}/cm^2$.

As such, as long as the solid solubility of the silicon wafer has not been exceeded by the implanted species (which is the case for the implants species of the above cited prior art and evidence references), Neilson et al can be modified such that its recombination centers also act/function as an ohmic contact.

Thus, when the combination of the secondary references to Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record) are applied to Neilson, the scope of Neilson remains unchanged since Neilson et al disclose suitable heat treatment (at least 800^{o} C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both

upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts. (Neilson et al, column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22)

While both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C at implant dosages substantially identical to Neilson et al (above 10^{14} species/cm^2). Thus, similar properties are presumed. Taken further, the wafer, implant species and doses, and annealing of Neilson et al in view of Kakumu and Yamamoto et al are identical to applicant disclosed and/or claimed wafers (silicon), implant species and doses, and annealing.

Thus, it would be expected that the results to be similar with respect to diffusion and ohmic contact formation. Therefore, a prima facie case of obviousness has been established since the combination of Neilson et al and Kakumu and Yamamoto et al discloses a substantially identical structure which is produced by a substantially identical process to the specification disclosed process and the claimed method. See MPEP § 2112.01 and 2112.02.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the recombination centers of Neilson as ohmic contacts since Neilson and the prior art of record to Kakumu and Yamamoto et al disclose process variations which affect the final device structure's performance; none of which would change the principal operation of Neilson et al as is evidenced by the above cited references a-d.

And, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ 2d 1647 (1987). See MPEP § 2114 [R-1].

C. In Re appellant's arguments that "Examiner's cited evidence does not support his position. The Examiner cites four additional references as evidence at pp. 16-17 of the Office Action issued February 1,2011. The Examiner's evidence supposedly supports a conclusion that "the recombination centers 20 formed in buffer layer 24 in FIGS. 2a-d would still function as recombination centers if an ohmic contact is formed. However, the Examiner does not make sufficient factual findings to support the above-noted position. The Examiner only characterizes these references as describing recombination centers, forming recombination centers, forming nickel silicide, or forming cobalt silicide. There are no findings of fact that any of these additional references teach that a transistor, such as the transistor of Nielson, would have

recombination centers that provided the stated goals and purposes of Nielson if an ohmic contact is formed. The Examiner makes no factual findings regarding whether the references discussed at pp. 16-17 of the Action mailed February 1, 2011 would still have recombination centers if they are modified to form an ohmic contact. The Examiner fails to identify a single one of these additional references as providing a teaching of both recombination centers and an ohmic contact being in a transistor. This is nothing more than an attempt to bring in isolated teachings into Neilson's device which amounts to improperly picking and choosing features from different references without regard to the teachings of the references as a whole. The Examiner has identified nothing within the art of record which would direct a person skilled in the pertinent art to make the selections necessary to have both recombination centers and an ohmic contact in the transistor of Neilson.

The examiner, respectfully, disagrees and takes the position that the recombination centers 20 formed in buffer layer 24 in FIGS. 2a-d would still function as recombination centers if an ohmic contact is formed since as stated above:

a. Narayan et al (4,181,538) disclose that recombination centers are present in silicon wafers up to a concentration of Cu or Fe (both of which are used by Neilson) of over $5x10^{21}/cm^3$ which corresponds to a dosage of over $10^{16}/cm^2$ (FIG. 6; column 11, lines 55-68 and column 12, lines 1-68).

b. Francis et al (2003/0057522 A1) disclose heavy metal (e.g. Au or Pt as does Neilson) ion implantation for forming recombination centers (FIGS. 1-3; ¶ [0011]-[0017]) in transistor structures.

c. Oostra et al (5,354,697) disclose forming NiSi (nickel silicide) layers in silicon wafers by ion implantion of Ni (Neilson discloses Ni recombination centers) with doses up to $3x10^{17}/cm^2$ (col. 8, lines 42-68 and col. 9, lines 1-48).

d. van Ommen et al (5,236,872) disclose forming $CoSi_2$ (cobalt silicide) layers in silicon wafers by implanting Co (Neilson discloses Co recombination centers) with doses up to $2.6x10^{16}/cm^2$ (col. 1, lines 55-61 and col. 2, lines 1-40).

The above cited references disclose that the metal ion implantations (applicant discloses Co, Ni, Ti, Cu or Pt) can be used for different applications which have varying degrees of quality dependent on the implantation and the subsequent anneal conditions. They all disclose formation of silicon-alloys (i.e. metal silicides) layers on or below the surface of a silicon wafer.

Neilson et al have not disclosed any limitations or restrictions which would preclude its structure from being implanted with a dose consistent with the claimed dosage of $10^{16}/cm^2$. This assertion, in conjunction with the above cited references, disclose forming recombination centers in silicon wafers comprising Co, Ni, Ti, Cu or Pt

implants with dosages up to $2.6x10^{16}/cm^2$ wherein silicides may be formed in conjunction with the recombination centers, and further provide evidence that such a formation of recombination centers at such a dosage would not destroy the operational intent of Neilson.

In fact, Neilson et al disclose that device speed is dependent on doping concentration (up to $10^{19}/cm^3$) corresponding to doses above $10^{14}/cm^2$ of the recombination centers (column 4, lines 35-55). Therefore, higher doping concentrations of the recombination centers is permissible via doses above $10^{14}/cm^2$ up to $2.6x10^{16}/cm^2$.

As such, as long as the solid solubility of the silicon wafer has not been exceeded by the implanted species (which is the case for the implants species of the above cited prior art and evidence references), Neilson et al can be modified such that its recombination centers also act/function as an ohmic contact.

Thus, when the combination of the secondary references to Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record) are applied to Neilson, the scope of Neilson remains unchanged since Neilson et al disclose suitable heat treatment (at least 800^o C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d),

the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts. (Neilson et al, column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22)

While both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C at implant dosages substantially identical to Neilson et al (above 10^{14} species/cm^2). Thus, similar properties are presumed. Taken further, the wafer, implant species and doses, and annealing of Neilson et al in view of Kakumu and Yamamoto et al are identical to applicant disclosed and/or claimed wafers (silicon), implant species and doses, and annealing.

Thus, it would be expected that the results to be similar with respect to diffusion and ohmic contact formation. Therefore, a prima facie case of obviousness has been established since the combination of Neilson et al and Kakumu and Yamamoto et al discloses a substantially identical structure which is produced by a substantially identical process to the specification disclosed process and the claimed method. See MPEP § 2112.01 and 2112.02.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the recombination centers of Neilson as ohmic contacts since Neilson and the prior art of record to Kakumu and Yamamoto et al disclose process variations which affect the final device structure's performance; none of which would change the principal operation of Neilson et al as is evidenced by the above cited references a-d.

And, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ 2d 1647 (1987). See MPEP § 2114 [R-1].

D. In Re appellant's arguments that "Kakumu does not cure the deficiencies of Neilson. One of ordinary skill in that art would not find it obvious to pick and choose the doping concentration disclosed by Kakumu in order to use it instead of the doping concentration of Neilson. There is no evidence that a person of ordinary skill in the art would have recognized any problem with the doping concentration of Neilson, nor would a person of ordinary skill in the art have any desire to reduce or eliminate the amount of recombination centers in the device of Neilson. Thus, there is no rationale for such a modification, absent improper hindsight based on the present claims. While Kakumu may provide a reason for using its doping concentration to form titanium-silicide layers on portions where the source and drain are formed in a transistor, Kakumu fails to explain why a person of ordinary skill in the art would find it obvious to incorporate such

a feature to form an ohmic contact at an interface between a blocking layer and a buffer layer of a transistor such as the one disclosed in Neilson. Page 3 of the Office Action issued February 1, 2011, with respect to combining Kakumu with Nielson, states "Kakumu discloses...implanting metallic species.., at a dose above 10^{16} species/cm^2.., to form reduced areas of resistance for ohmic contacts." The Examiner goes on to state that it would be obvious to use this feature in .Neilson "to form areas of reduced resistance to carrier flow." However, there is no finding of fact, supported by substantial evidence, that Neilson requires reduced resistance to carrier flow. On the contrary,.....Neilson makes it clear that the resistivity of the blocking layer isincreased. Adding an ohmic contact as suggested by the Examiner would have the opposite effect than what is taught by Neilson (i.e., lower the resistivity). Moreover, the difference between the doping concentration of Neilson and that of Kakumu is significant (i.e., an order of magnitude). The Examiner has failed to provide any explanation regarding why Kakumu's doping concentration, if used in the embodiments discussed in Neilson, would predictably provide for the same results. Col. 4, ll. 57-59 of Neilson states "the dopant may be selected to provide optimum switching performance (if this is desired) without regard for its solubility or diffusion coefficient." The "without regard for its solubility or diffusion coefficient" is in agreement with a very low concentration, very far from saturation where solubility is not yet a problem. Neilson's solubility is too low to form an ohmic contact. There is no evidence that a person of ordinary skill in the art would alter or modify Neilson to implant a substrate above the limit of solubility to achieve an ohmic contact. Such a change would alter the nature of Neilson's device by changing the

device from a transistor to an electrical contact.19 Further, such a modification to Neilson would render Neilson's device unsatisfactory for its intended purpose (i.e., it would no longer be a transistor). Furthermore, in Kakumu, the doped regions 18 cannot be at an interface between two substrates because of elements 13 and 16 (Fig. 2D of Kakumu) or elements 16, 27, and 28 (Fig. 2G of Kakumu) materially prevent a second substrate from being brought in contact with substrate 10. A person of ordinary skill in the art would not appreciate that techniques from Kakumu would form an ohmic contact "at an assembly interface between the first wafer and the second wafer." Thus, a proper combination of Neilson and Kakumu does not lead to the claimed invention."

The examiner, respectfully, disagrees and takes the position that the recombination centers 20 formed in buffer layer 24 in FIGS. 2a-d would still function as recombination centers if an ohmic contact is formed since as stated above:

a. Narayan et al (4,181,538) disclose that recombination centers are present in silicon wafers up to a concentration of Cu or Fe (both of which are used by Neilson) of over $5x10^{21}/cm^3$ which corresponds to a dosage of over $10^{16}/cm^2$ (FIG. 6; column 11, lines 55-68 and column 12, lines 1-68).

b. Francis et al (2003/0057522 A1) disclose heavy metal (e.g. Au or Pt as does Neilson) ion implantation for forming recombination centers (FIGS. 1-3; ¶ [0011]-[0017]) in transistor structures.

c. Oostra et al (5,354,697) disclose forming NiSi (nickel silicide) layers in silicon wafers by ion implantion of Ni (Neilson discloses Ni recombination centers) with doses up to $3x10^{17}/cm^2$ (col. 8, lines 42-68 and col. 9, lines 1-48).

d. van Ommen et al (5,236,872) disclose forming $CoSi_2$ (cobalt silicide) layers in silicon wafers by implanting Co (Neilson discloses Co recombination centers) with doses up to $2.6x10^{16}/cm^2$ (col. 1, lines 55-61 and col. 2, lines 1-40).

The above cited references disclose that the metal ion implantations (applicant discloses Co, Ni, Ti, Cu or Pt) can be used for different applications which have varying degrees of quality dependent on the implantation and the subsequent anneal conditions. They all disclose formation of silicon-alloys (i.e. metal silicides) layers on or below the surface of a silicon wafer.

Neilson et al have not disclosed any limitations or restrictions which would preclude its structure from being implanted with a dose consistent with the claimed dosage of $10^{16}/cm^2$. This assertion, in conjunction with the above cited references, disclose forming recombination centers in silicon wafers comprising Co, Ni, Ti, Cu or Pt implants with dosages up to $2.6x10^{16}/cm^2$ wherein silicides may be formed in conjunction with the recombination centers, and further provide evidence that such a

formation of recombination centers at such a dosage would not destroy the operational intent of Neilson.

In fact, Neilson et al disclose that device speed is dependent on doping concentration (up to $10^{19}/cm^3$) corresponding to doses above $10^{14}/cm^2$ of the recombination centers (column 4, lines 35-55). Therefore, higher doping concentrations of the recombination centers is permissible via doses above $10^{14}/cm^2$ up to $2.6x10^{16}/cm^2$.

As such, as long as the solid solubility of the silicon wafer has not been exceeded by the implanted species (which is the case for the implants species of the above cited prior art and evidence references), Neilson et al can be modified such that its recombination centers also act/function as an ohmic contact.

Further, Neilson et al disclose that the recombination centers (20) are concentrated at an interface between to bonded wafers (FIGS. 2a-2d and 3; column 4, lines 35-55), and absent from the blocking layer (22). Therefore, the intended purpose of the blocking layer has not been stymied, defeated or altered as the applicant argues.

Thus, when the combination of the secondary references to Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record) are applied to Neilson, the scope of Neilson remains unchanged since Neilson et al disclose suitable

heat treatment (at least 800° C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts. (Neilson et al, column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22)

While both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C at implant dosages substantially identical to Neilson et al (above 10^{14} species/cm^2). Thus, similar properties are presumed. Taken further, the wafer, implant species and doses, and annealing of Neilson et al in view of Kakumu and Yamamoto et al are identical to applicant disclosed and/or claimed wafers (silicon), implant species and doses, and annealing.

Further, Kakumu is being relied upon to demonstrate the use of implanted species (Ni and Pt) as claimed by the applicant up to and above doses (10^{16}/cm^2) claimed by the applicant for use as an area of resistance for ohmic contacts, not its non-disclosure of being bonded to another wafer.

Thus, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986)

Thus, it would be expected that the results to be similar with respect to diffusion and ohmic contact formation. Therefore, a prima facie case of obviousness has been established since the combination of Neilson et al and Kakumu and Yamamoto et al discloses a substantially identical structure which is produced by a substantially identical process to the specification disclosed process and the claimed method. See MPEP § 2112.01 and 2112.02.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the recombination centers of Neilson as ohmic contacts since Neilson and the prior art of record to Kakumu and Yamamoto et al disclose process variations which affect the final device structure's performance; none of which would change the principal operation of Neilson et al as is evidenced by the above cited references a-d.

And, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed

apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ 2d 1647 (1987). See MPEP § 2114 [R-1].

E. In Re appellant's arguments that "Yamamoto does not cure the deficiencies of Neilson. While Yamamoto may provide a reason for forming a silicide "into a desired surface region of a silicon substrate" in its device, Yamamoto fails to explain why a person of ordinary skill in the art would find it obvious to incorporate such a feature to form an ohmic contact at an interface between a blocking layer and a buffer layer of a transistor such as the one disclosed in Neilson. Moreover, it is not the silicide in Yamamoto that makes an ohmic contact. Rather, it is electrode material (see, col. 3, 11.14-23 of Yamamoto stating "and ohmic contact can be formed with the Si substrate when the metal...and after the heat treatment...the electrode and wiring made of W, Mo, or Al are formed on the resulting silicide or alloy layer" (emphasis added). Thus, Yamamoto does not teach "forming a metallic ohmic contact including alloys formed between the implanted metallic species and the semiconducting materials of the first wafer and the second wafer." Page 4 of the Office Action issued February 1, 2011 states that Yamamoto is combined with Neilson "to form alloyed or sillicide areas of reduced resistance." This is contrary to the teachings of Neilson as noted above, wherein Neilson teaches that the resistivity of the blocking layer is increased. In view of the above-noted distinctions, a proper combination of Nielson, Kakamu and Yamamoto does not disclose every feature of independent Claims 27 and 65. Thus, a proper

combination of Nielson, Kakamu, and Yamamoto does not render Claims 27-29, 31- 45, 53-57, and 65 obvious.

The examiner, respectfully, disagrees and takes the position that the recombination centers 20 formed in buffer layer 24 in FIGS. 2a-d would still function as recombination centers if an ohmic contact is formed since as stated above:

a. Narayan et al (4,181,538) disclose that recombination centers are present in silicon wafers up to a concentration of Cu or Fe (both of which are used by Neilson) of over $5x10^{21}/cm^3$ which corresponds to a dosage of over $10^{16}/cm^2$ (FIG. 6; column 11, lines 55-68 and column 12, lines 1-68).

b. Francis et al (2003/0057522 A1) disclose heavy metal (e.g. Au or Pt as does Neilson) ion implantation for forming recombination centers (FIGS. 1-3; ¶ [0011]-[0017]) in transistor structures.

c. Oostra et al (5,354,697) disclose forming NiSi (nickel silicide) layers in silicon wafers by ion implantion of Ni (Neilson discloses Ni recombination centers) with doses up to $3x10^{17}/cm^2$ (col. 8, lines 42-68 and col. 9, lines 1-48).

d. van Ommen et al (5,236,872) disclose forming $CoSi_2$ (cobalt silicide) layers in silicon wafers by implanting Co (Neilson discloses Co recombination centers) with doses up to $2.6x10^{16}/cm^2$ (col. 1, lines 55-61 and col. 2, lines 1-40).

The above cited references disclose that the metal ion implantations (applicant discloses Co, Ni, Ti, Cu or Pt) can be used for different applications which have varying degrees of quality dependent on the implantation and the subsequent anneal conditions. They all disclose formation of silicon-alloys (i.e. metal silicides) layers on or below the surface of a silicon wafer.

Neilson et al have not disclosed any limitations or restrictions which would preclude its structure from being implanted with a dose consistent with the claimed dosage of $10^{16}/cm^2$. This assertion, in conjunction with the above cited references, disclose forming recombination centers in silicon wafers comprising Co, Ni, Ti, Cu or Pt implants with dosages up to $2.6x10^{16}/cm^2$ wherein silicides may be formed in conjunction with the recombination centers, and further provide evidence that such a formation of recombination centers at such a dosage would not destroy the operational intent of Neilson.

In fact, Neilson et al disclose that device speed is dependent on doping concentration (up to $10^{19}/cm^3$) corresponding to doses above $10^{14}/cm^2$ of the recombination centers (column 4, lines 35-55). Therefore, higher doping concentrations

of the recombination centers is permissible via doses above $10^{14}/cm^2$ up to $2.6x10^{16}/cm^2$.

As such, as long as the solid solubility of the silicon wafer has not been exceeded by the implanted species (which is the case for the implants species of the above cited prior art and evidence references), Neilson et al can be modified such that its recombination centers also act/function as an ohmic contact.

Further, Neilson et al disclose that the recombination centers (20) are concentrated at an interface between to bonded wafers (FIGS. 2a-2d and 3; column 4, lines 35-55), and absent from the blocking layer (22). Therefore, the intended purpose of the blocking layer has not been stymied, defeated or altered as the applicant argues.

Thus, when the combination of the secondary references to Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record) are applied to Neilson, the scope of Neilson remains unchanged since Neilson et al disclose suitable heat treatment (at least 800° C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts

generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts. (Neilson et al, column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22)

While both Kakumu (column 2, lines 28-42) and Yamamoto et al (column 5, lines 57-62) disclose forming metallic-silicon alloys and silicides at at least 400° C at implant dosages substantially identical to Neilson et al (above 10^{14} species/cm^2). Thus, similar properties are presumed. Taken further, the wafer, implant species and doses, and annealing of Neilson et al in view of Kakumu and Yamamoto et al are identical to applicant disclosed and/or claimed wafers (silicon), implant species and doses, and annealing.

Further, Yamamoto et al is being relied upon to demonstrate forming a metallic ohmic contact including a alloy or silicide formed between the implanted metallic species at doses above $5x10^{16}$ species/cm^2 and the semiconducting materials of a wafer, said metallic ohmic contact being formed from the surface of the wafer to a depth of 5 nm, wherein the forming includes causing the implanted metallic species to diffuse towards the surface of the wafer (column 2, lines 15-33; column 3, lines 1-23 and column 6, lines 32-68).

Thus, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. *In re Keller*, 642 F.2d

413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986)

Thus, it would be expected that the results to be similar with respect to diffusion and ohmic contact formation. Therefore, a prima facie case of obviousness has been established since the combination of Neilson et al and Kakumu and Yamamoto et al discloses a substantially identical structure which is produced by a substantially identical process to the specification disclosed process and the claimed method. See MPEP § 2112.01 and 2112.02.

Lastly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the recombination centers of Neilson as ohmic contacts since Neilson and the prior art of record to Kakumu and Yamamoto et al disclose process variations which affect the final device structure's performance; none of which would change the principal operation of Neilson et al as is evidenced by the above cited references a-d.

And, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ 2d 1647 (1987). See MPEP § 2114 [R-1].

F. In Re appellant's arguments that "Kakumu and Yamamoto fail to teach the claimed "wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface". As explained above, the Examiner's finding that Neilson teaches the claimed "wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface" is incorrect. Kakumu and Kamamoto fail to teach the claimed "wherein the forming includes causing the implanted metallic species to diffuse towards the interface between the first wafer with the second wafer and beyond the interface."

The examiner, respectfully, disagrees with the immediately above arguments and takes the position that:

Neilson et al have not disclosed any limitations or restrictions which would preclude its structure from being implanted with a dose consistent with the claimed dosage of $10^{16}/cm^2$. This assertion, in conjunction with the above cited references, disclose forming recombination centers in silicon wafers comprising Co, Ni, Ti, Cu or Pt implants with dosages up to $2.6x10^{16}/cm^2$ wherein silicides may be formed in conjunction with the recombination centers, and further provide evidence that such a formation of recombination centers at such a dosage would not destroy the operational intent of Neilson.

In fact, Neilson et al disclose that device speed is dependent on doping concentration (up to $10^{19}/cm^3$) corresponding to doses above $10^{14}/cm^2$ of the recombination centers (column 4, lines 35-55). Therefore, higher doping concentrations of the recombination centers is permissible via doses above $10^{14}/cm^2$ up to $2.6x10^{16}/cm^2$.

As such, as long as the solid solubility of the silicon wafer has not been exceeded by the implanted species (which is the case for the implants species of the above cited prior art and evidence references), Neilson et al can be modified such that its recombination centers also act/function as an ohmic contact.

Further, Neilson et al disclose that the recombination centers (20) are concentrated at an interface between to bonded wafers (FIGS. 2a-2d and 3; column 4, lines 35-55), and absent from the blocking layer (22) ***having been formed on or below the surface of the two wafers to be bonded***. Therefore, the intended purpose of the blocking layer has not been stymied, defeated or altered as the applicant argues.

Thus, when the combination of the secondary references to Kakumu (5,654,241-prior art of record) and Yamamoto et al (4,577,396-prior art of record) are applied to Neilson, the scope of Neilson remains unchanged since Neilson et al disclose suitable heat treatment (at least 800° C) can be performed after a molecular bond between the first and second wafers, which causes the metallic implant species to diffuse, both

upward and downward, across the first and second wafer interface (20 in FIGS. 2a-d), the metallic species would obviously react with the silicon wafers to form metallic-silicon alloys or silicides which could functions as ohmic (metal-semiconductor: See Sze et al, 1st, 2nd or 3rd Ed. 1969, 1981, 2007; Chapter 3, Section 3.6 states that ohmic contacts generally have doping concentrations of 10^{17} to 10^{21} species/cm^3 which would be satisfied by dosages above 10^{14} species/cm^2) contacts. (Neilson et al, column 3, lines 7-20; column 4, lines 25-55 column 5, lines 5-22)

While Yamamoto et al is being relied upon to demonstrate forming a metallic ohmic contact including a alloy or silicide formed between the implanted metallic species at doses above $5x10^{16}$ species/cm^2 and the semiconducting materials of a wafer, said metallic ohmic contact being formed from the surface of the wafer to a depth of 5 nm, wherein the forming includes causing the implanted metallic species to diffuse towards the surface of the wafer (column 2, lines 15-33; column 3, lines 1-23 and column 6, lines 32-68).

Therefore, Neilson et al and Yamamoto et al both disclose diffusion of implanted species in a wafer. In either case, diffusion is not limited to any one direction, but rather in all directions.

Thus, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. *In re Keller*, 642 F.2d

413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986)

Thus, it would be expected that the results to be similar with respect to diffusion and ohmic contact formation. Therefore, a prima facie case of obviousness has been established since the combination of Neilson et al and Kakumu and Yamamoto et al discloses a substantially identical structure which is produced by a substantially identical process to the specification disclosed process and the claimed method. See MPEP § 2112.01 and 2112.02.

Lastly, it has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ 2d 1647 (1987). See MPEP § 2114 [R-1].

2.

A. In Re appellant's arguments that "The rejection of Claims 31-33 and 55-57 as unpatentable over Neilson Kakumu and Yamamoto and further in view of Kish and Abe is incorrect.....The rejection of Claims 37 38 and 44 as unpatentable over Neilson Kakumu and Yamamoto, and further in view of Kub is incorrect.....The rejection of Claims 39 and 40 as unpatentable over Neilson Kakumu and Yamamoto, and further in view Yu is incorrect, and are patentable for at least the reasons stated above."

The examiner, respectfully, disagrees with the immediately above arguments in view of the examiner's above rebuttals.

Further, since no arguments have been put forth with the respect to the above cited references to Kish et al and Abe et al; or Kub et al; or Yu et al, the examiner deems the immediately above cited rejections to be proper in view of all of the above examiner rebuttals.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/ERIC W JONES/
Examiner, Art Unit 2892
12/6/2011

Conferees:

/Thao X Le/
Supervisory Patent Examiner, Art Unit 2892

/Brian Sircus/
Brian Sircus, TQAS TC 2800